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TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

1881-1882.

EDITOR,

ALEXIS A. JULIEN,

School of Mines Columbia College, N. Y. City.

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eers. He was also a member of the United States Commission for testing iron and steel.

Since 1872, he has written eighteen papers for various societies, contributed to SCRIBNER'S *Monthly Magazine*, and last, but not least, became Lecturer on Iron and Steel at the School of Mines of Columbia College. In the latter office, he was beloved of all the students who had the good fortune to hear him. His calm delivery, his carefully rounded sentences, and his pre minently practical manner of treating his subject insured an amount of attention that few lecturers enjoy. The kind answer to a question, the evident endeavor to put himself in the student's place as an inquirer, made him attractive to all, and his lectures were looked forward to, as hours of intellectual enjoyment and profit. He died in Brooklyn, January 29, 1882, from peritonitis, and lies buried in Greenwood Cemetery.

Such is a very brief record of a life that was busy beyond comparison. As a mechanical engineer, a railroad engineer, a military engineer, or a metallurgical engineer, Mr. HOLLEY could claim a position among the greatest; but when we reflect that he was eminent in each of these branches of the science of engineering, we stand bewildered at the power of brain, and the untiring energy that carried him to such a height. As a proof of his greatness, there is not to-day a man who can at once fill his place in the engineering world. But it cannot be doubted that he was prodigal of his strength, and often did more work than his wonderfully vigorous mind could bear. The tenacious metal, that he loved so well, would scarcely have been tough enough for the body to carry such a mind, and the intoxication of vigor often leads the best of us to feats of endurance from which in our calmer moments we shrink.

From every steel-works in America, from the glowing throat of every converter, there comes a radiance directed to but one point, the illumination of the name of ALEXANDER LYMAN HOLLEY; a name not to be forgotten where the watch-spring or the suspension bridge are born of American steel.

ARTHUR H. ELLIOTT,
THOMAS EGLESTON, } *Committee.*

Prof. THOMAS EGLESTON then presented the regular paper of the evening, entitled:

THE PROPOSED GOVERNMENT COMMISSION FOR THE TESTING OF IRON AND STEEL.*

* Published in Trans. Inst. Mech. Engineers, Phila. meeting, Feb., 1882.

April 3, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

There was a large attendance, occupying the new lecture hall.

The report of the Council was read, recommending the election of the following persons as Resident Members:

GEORGE GREGORY, GEORGE F. STEVENS;

and they were thereupon unanimously elected.

The Council also recommended, and the Academy voted, the change in the subscription price of the Annals, suggested by the Publication Committee, viz., from $2.00 a year to the following rates:

To resident and honorary members, two dollars a year, as before.

To others, non-residents of New York City, three dollars.

To residents of the city who are not members of the Academy, five dollars.

Dr. GEORGE M. BEARD presented the paper of the evening, entitled:

A PSYCHOLOGICAL EXPLANATION OF THE SALEM WITCHCRAFT EXCITEMENT, AND THE PRACTICAL LESSONS TO BE DERIVED THEREFROM.

(Abstract.)

Dr. BEARD sketched briefly the facts of the celebrated "Salem witchcraft," and referred to the views now generally held, which have regarded it as a combination of deception, delusion, superstition and bigotry. He claimed that much in these views ought to be modified in the light of modern scientific research, and also of historical justice. He had sought to study the matter impartially, from the standpoint of scientific psychology; and after reaching conclusions which gave to his own mind a much clearer understanding of the whole phenomenon, he had visited Salem and gone over the ground as carefully as possible, only to find his conclusions more firmly established. In his view, many of the facts, alleged upon the trials of accused persons at Salem, find their explanation—now for the first time—in well-marked symptoms of the trance state, then wholly uncomprehended, and even now but little known save to specialists in that department. The men who tried and condemned the unfortunate victims of this melancholy affair were neither fools nor wanton persecutors; they were among the most cultivated

and earnest men of the colony, and acted under a profound, though most erroneous, sense of responsibility. They are not to be denounced as judicial murderers of their friends and townspeople, as has been often, and unjustly, done, but must be looked upon as honest and earnest, though sadly mistaken and unenlightened men.

A large part of the testimony on these trials consisted of that given by various young persons—the so-called "afflicted children"—to the fact of their having been bewitched by certain suspected individuals; and these children would be seized with convulsive movements upon being confronted with the persons charged. Here was, apparently, the most positive evidence, plain to all, and given before the eyes of the judges. No other explanation was then known of such facts than that of actual sorcery, which was universally believed to be the result and manifestation of an accursed compact with a personal Evil Spirit. For such diabolical intercourse, the penalty was death; and with such clear evidence of fact, and with no other explanation of those facts known or imagined, both law and logic forced the judges to condemn the accused to death.

(Dr. BEARD here produced two lads, liable to the trance condition, and called their attention to the President of the Society, occupying the Chair; first one and then the other, with no apparent cause, went into convulsions, from which they were recalled in a moment or two by Dr. BEARD, and helped into chairs, where they very speedily passed into a state of sleep.)

Here, remarked the lecturer, we have illustrated the case of the "afflicted children." He read passages from the records of the trials, where precisely such manifestations took place. The accused persons would solemnly deny the exercise or possession of any diabolical arts. They would then be asked how it was, in that case, that these children were thrown into such a state, on merely being confronted with them. To this they could give no answer, save that they knew not indeed, but that still they were innocent. The condemnation of the accused was then a logical necessity, to the belief of that time. Those who confessed were pardoned or let off with a lighter penalty; but those who denied, and protested their innocence, were sentenced to death as witches.

The only ground on which this mournful and tragical result could have been avoided, in the state of knowledge and belief two centuries ago, was the question as to the validity of testimony given by those who were possessed or bewitched. This might have afforded an escape from the otherwise inevitable consequence, and it is much to the credit of the clergy of that time that they were strongly disposed to urge this doubt and to reject the evidence thus given. COTTON

MATHER distinctly expressed his serious concern as to the acceptance of such testimony. But the lawyers and judges were not to be shaken in their adherence to the rule of legal precedent; decision after decision was cited from the old English courts, admitting such evidence in trials for witchcraft, and the more cautious and humane disposition of the ministers was overborne by the stern and rigid influence of the law. Yet this, be it remembered, is the lawyer's rule of action. The judges were bound to conform to the precedents of former procedure; and however mournful the result, and however revolting to the sentiments and beliefs of a more enlightened age, yet the Salem judges were faithful to their professional rules and their official responsibility. We must judge them by these, and not by the standards of to-day.

The Salem witchcraft was the last chapter in the long and bloody record of trials for sorcery and necromancy, which casts its shadow over many a page of European history. It had already ceased on the Continent and in England, and here in the New World colonies it had this one tragical outbreak, and then exhausted itself never to recur. It is not claimed that the views here presented are the explanation of all that then occurred; there were in some cases sinister motives actuating persons who made charges; there was in other cases, perhaps, actual deception. But it is believed that a large part of the evidence, that was most critical and most convincing, can be explained, in the way here suggested, with great ease and naturalness; and it is moreover due to the men of that time, to bear in mind the ignorance of science amid which they lived and the bonds of legal precedent in which they were held, and so to clear their memory from unjust severity of reprobation.

DISCUSSION.

A long and active discussion, covering a wide range of subjects, arose after the paper of Dr. BEARD.

Dr. BENJAMIN N. MARTIN expressed his very profound interest in the views presented. At the same time he was inclined to believe that a good deal of the testimony referred to arose from the disposition of some children to mere mischief and trickery, for the amusement afforded them in perplexing and mystifying grave and elderly persons by odd devices and pranks. He cited recent cases of marvellous "manifestations," of ghostly china-breaking and unaccountable noises, etc., finally traced to mischievous children; and questioned whether much of the Salem evidence may not have been of this kind.

Mrs. ERMINNIE A. SMITH spoke of her studies and observations among the Indian tribes on the New York State Reservations, and

of the deeply-rooted belief in witchcraft, etc., that is to be found there, even where the people have taken on the externals of civilization. She proposed the question whether, in view of the credence given to spiritualism and the like among our own people, the claim of a great advance in culture and enlightenment, from these ruder, but kindred, superstitions, could be consistently maintained.

Dr. BEARD replied that, as regards spiritualism, it is precisely as Mrs. SMITH had said, a manifestation of the same kind; but the superstition is of a milder type, lacking the ferocious and tragical features that belong to the witchcraft delusion, and herein lies the advance and the improvement.

Several other members discussed various aspects of the paper of Dr. BEARD.

April 10, 1882.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons present.

THE SECRETARY referred to the arrival, a day or two before, of the remarkably large African elephant, "Jumbo," sold from the London Zoölogical Gardens, on account of supposed vicious disposition. He noted certain of the differences between the two species of elephants, the African and the Asiatic—the former being reported as generally larger, and also readily distinguished by the great size of the ears.

THE PRESIDENT commented on the same subject, and illustrated by blackboard drawings the distinctive features of the teeth in the two species. The teeth of the Asiatic elephant, like those of our American fossil species, are crossed by parallel ridges of enamel and dentine; while in the African elephant the plates are waved in such wise as to produce not parallel, but lozenge-shaped ridges on the crown of the tooth.

Mr. F. G. WEICHMANN then read a paper entitled:

FUSION-STRUCTURES IN METEORITES.

(Abstract.)*

After referring in general to the peculiar interest which attaches to meteorites, and the uncertainty as to their real nature which is still felt

*This paper is printed in full in the ANNALS of the Academy, Vol. II, No. 10.

among scientists, Mr. WIECHMANN alluded briefly to four principal theories of their origin, as (a) Terrestrial Volcanic, (b) Lunar Volcanic, (c) Planetary, or (d) Cometary. There are many objections to the theories that regard them as belonging to the earth or its satellite, on the one hand, or as visitants from distant space, on the other; and preference is doubtless due to the view that these bodies belong to the planetary system—perhaps as fragments of asteroids that may once have collided. As regards the differences in their mineral and chemical characters, which have led to various classifications, that of DAUBREE alone was given. According to him, meteoric stones are divided into (1) Siderites and (2) Asiderites, according as they are composed of metallic iron (wholly or partly), or do not contain that substance. The former class, the Siderous meteorites, he again divides into Holosiderous, Syssiderous, and Sporasiderous—according to the amount in which the iron is present. Various analyses of meteorites were then given.

Mr. WIECHMANN next proceeded to his own researches upon meteorites, describing the manner of examining microscopic sections, and certain adjustments thereof with reference to the use of polarized light. A list of seventeen specimens was given, with the dates and localities of their fall, from which he had prepared and studied numerous sections, and also of various volcanic rocks examined in the same manner for comparison. His attention had been chiefly given to certain very peculiar and characteristic forms which are found in many meteorites, and to which he gave the designation of "*Fusion-Structures.*"

These structures are not crystal forms, as they lack the definite angular character that belongs to the latter; their outlines are often rounded, and their aspect curiously suggestive of organic structures. They might fall under ZIRKEL'S definition of what he calls *crystallites*, i. e., mineral formations possessing a radiate arrangement or grouping, but not showing, either as a whole or in their parts, any regular properties or outlines of crystallized bodies. It is these "fusion-structures' which have been regarded, in the recent well known work of OTTO HAHN, as representing true organic remains.

The structures of this kind which Mr. WIECHMANN had found in the sections prepared by him, were then described, and illustrated by a series of very finely prepared drawings, displaying their characters as seen at various magnifying powers, from 75 to 1500 diameters. It was shown that, in some cases, the organic aspect, presented under a low power, disappears entirely upon greater magnification. After discussing these, the author declared his inability to discover any forms that seemed really organic, and criticised various points asserted in Dr. HAHN'S work, as distinctly negatived in his own observations.

The sections of volcanic rocks were then shown and described in the same manner as those of the meteorites had been; and the interesting result was brought out, of a very close similarity in the microscopic structure of various specimens of these two classes of bodies. Whatever theory be held as to the origin of meteorites, that of volcanic rocks is sufficiently known and universally admitted: they have cooled from a state of fusion. If, therefore, a likeness of internal microscopic structure appears in the two kinds of bodies—besides in many cases a close resemblance in composition—we may safely conclude that meteorites also have passed through a fused condition, and that the structures in question have originated in them as they have in volcanic rocks.

Numerous other points were treated of in this paper, *e. g.*, the probable origin of the "crystallites" or "fusion structures" in igneous rocks, as due to unequal rates of cooling among the different constituents of the fused mass, resulting in the segregation of minute portions scattered through the rock; also the effect upon meteorites of the friction-heat developed in passing through the earth's atmosphere, which effect is plainly shown in the sections, but is seen to be only superficial. For these and other details, reference must be made to the article as published in the Annals.

DISCUSSION.

Prof. R. P. WHITFIELD, DR. NEWBERRY and others discussed the paper briefly, agreeing with the views therein expressed, and welcoming its presentation, and also dissenting entirely from the views of Dr. HAHN, as to the presence of organic remains in meteorites.

April 17, 1882.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present.

CHEVALIER ERNST VON HESSE-WARTEGG delivered the lecture of the evening.

THE SUBMARINE TUNNEL BETWEEN ENGLAND AND FRANCE.

(Abstract.)

In regard to the necessity of such an enterprise, reference was first made to the well-known and very peculiar discomforts of the passage of the Channel in boats, and to the aggravation thereof by the poor construction and worse management of the steamers employed. In-

stances of these grounds of criticism were given as examples, and of the natural difficulties, moreover, which often involve great and unavoidable delays and irregularities in the transit of both passengers and mails. Under these circumstances, the great desirableness of some improved means of travel is apparent at a glance, when it is remembered that a country of 30,000,000 of inhabitants is to be connected with a continent of 300,000,000, and that some 700,000 passengers annually make this passage.

If the commercial aspect be regarded, it is found that the yearly interchange of products between England and the continent amounts to a hundred millions of pounds sterling in value, and employs vessels aggregating a tonnage of ten millions. There could be no question of the financial success of such an undertaking as the proposed tunnel, where so large a business in both freight and passengers is subjected to so many inconveniences. If America had been similarly situated, such a work would long since have been accomplished; but the conservatism and the political anxiety of the English people have interposed serious obstacles.

Some seven years ago the proposal was first discussed, and the financial and engineering possibilities were largely debated, but no political difficulties were then raised. Only of late has this aspect been presented, and a formidable opposition made to the construction of the tunnel, on the part of both the people and the Parliament of England. This objection the lecturer considered most unwise and unjustifiable, a selfish hindering of a great enterprise of general importance and advantage. The St. Gothard Tunnel, or the railway over the Pyrenees, would be open to the same objection of a possible political danger; but none of the nations thus connected had for that reason opposed these great works of intercommunication. Nothing could be easier or simpler than to guard the entrance to a tunnel, especially when that tunnel lies beneath the sea, and could be flooded and closed at the first intimation of a foreign invasion.

Turning to the scientific aspect of the work, reference was made to the character of the material in which the tunnel is to be wrought. This is found to be chalk throughout, the well-known chalk of the Dover cliffs extending under the channel all the way. The work of excavation is therefore easy; the question might arise, however, how far this soft rock would prove impervious to the water. This had been tested by careful experiments; and it was proved that, even under heavy pressure, a small thickness of chalk allowed scarcely any perceptible passage to water.

The construction of the tunnel was next described, and illustrated by drawings. Its general section-form would be that of a low horse-shoe,

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nineteen feet in width by twenty-four in height. The whole would be lined with brick; but this brick wall and arch would not be quite in contact with the chalk excavation, but a space was to be left between, to allow any percolating water to pass down without entering the tunnel-way and escape beneath its floor. This escape would be secured by the slope of the tunnel, which is to be highest at the middle and descending somewhat toward each end, where large reservoirs will be excavated for any accumulating water, which will thence be removed by powerful steam pumps, raising it through shafts to the surface. The important matter of ventilation is to be provided for by engines at either extremity, so working as to insure a steady and powerful current of air through the entire tunnel, one pumping air, and the other exhausting it.

The machinery employed in the work of excavation was also referred to and illustrated; but it is peculiar and complicated, and cannot be well described, save at length and with figures. In working through the comparatively soft chalk, the process is strictly one of cutting; and a very ingenious and beautiful machine is employed, wherein a series of blades, like knives set upon revolving wheels, is made to cut the chalk at the extremity of the boring. The machine itself is also advanced on wheels, as it works onward the heading from day to day. Thirty-six feet is about the daily rate of progress; and it is computed that the whole will be finished in five or six years.

Estimates were then given of the profits which it is expected will be realized, if the work is successfully completed. The amount of funds requisite to do this will be forty to fifty millions of dollars; say, ten millions of pounds sterling. Three-fourths of the present passenger traffic should, it is altogether probable, prefer the tunnel to the channel voyage; and, considering the advantage in freight-transit of not "breaking bulk" for shipment, the receipts may be estimated roughly as follows:

Passenger travel	£850,000
Freight	300,000
Mail service, etc	50,000
Total	£1,200,000

Deducting from this, say, forty per cent. for expenses (£480,000), or somewhat less, there will remain a profit of £720,000, or more, which would yield from seven to seven and a half per cent. yearly on the capital of £10,000,000. If this capital seems large, it is not so in comparison with the sum already invested in the English railways, which amounts to about £700,000,000.

For his own part, the lecturer was fully convinced alike of the need,

the practicability and the financial success of this great enterprise; and he had no doubt that ladies and gentlemen now in his audience would yet pass through this submarine tunnel, on their way between Paris and London.

At the close of the lecture, complimentary remarks were made by the PRESIDENT and Dr. B. N. MARTIN; and on motion the interest and gratification of the Academy was expressed in a resolution of thanks to COUNT WARTEGG.

April 24, 1882.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the chair.

Twenty-seven persons present.

The receipt of interesting letters from Dr. JULIEN, the recently elected Vice-President of the Academy, was announced by President NEWBERRY, with notes of much scientific value regarding the explorations in which he is engaged in the islands off the coast of Venezuela, particularly on Aruba. Dr. JULIEN reports there large guano deposits, and discovers proofs of a series of repeated changes of level. He is collecting in several departments of zoölogy, and will have much interesting matter to lay before the Society on his return.

Dr. JULIEN proposed the name of the Governor of the island of Buen Ayre, JOHAN F. W. GRAVENHORST, a gentlemen of scientific culture, as a Corresponding Member of the Academy, and he was at once unanimously elected.

Dr. B. N. MARTIN referred to the very remarkable display of aurora during nearly the whole night of the 16th inst., as did also the President. A brilliant corona was formed; the entire sky was covered with tremulous sheets and waves of white light; and all the telegraph wires were rendered useless for a time in New York, while the disturbance reached widely over the country and even affected the submarine cables.

The death of one of the oldest Fellows of the Academy, Mr. WM. H. LEGGETT, was announced by Dr. MARTIN, and he and the President gave outlines of the personal and scientific record of Mr. LEGGETT, of his scholarly attainments, especially in Greek, of his

great devotion to botany, and of his long interest in the Academy and its work.

The President also announced the death of the eminent Mr. CHARLES R. DARWIN, Honorary Member of the Academy, and discussed the great importance of his labors in enlarging the modes of investigation in biology.

Prof. JOHN J. STEVENSON then read the following paper:

THE MINERAL RESOURCES OF SOUTHWEST VIRGINIA.

The Virginias were surveyed by Prof. W. B. ROGERS and a competent corps of assistant geologists during the five years previous to 1841, but the final report was not published and only a few copies of the annual reports were printed. The latter are now so rare that practically the only available information respecting the geology of Virginia is that obtained by examinations made for private parties or corporations.

The region to which attention is called extends from New River to the Tennessee line, and lies between the Great Valley of Virginia at the southeast and the State line at the northwest. It is drained by the Clinch and Holston Rivers, except in the northeast, where the waters flow into New River, a tributary of the Ohio.

The surface is rugged throughout, there being nine ranges of mountains between Bristol on the Tennessee border and the Kentucky line, a distance of little more than forty-five miles. Some of these ranges are very abrupt, and water-gaps are widely separated; so that between the Tennessee line and New River, a distance of not far from 120 miles, only two really good railroad routes have been found from the Valley to the coal-field, and these are available only for narrow-gauge roads.

This ruggedness is due to upthrow faults, of which seven occur between the Valley and the coal-field, a distance of about thirty miles. The Medina, the great mountain-making rock of the Appalachian region, is brought up four times in the interval. The effect of these faults on the agricultural conditions is curious, for the area is divided into alternating poor and rich valleys; the former underlaid by the Upper Silurian or Devonian shales, while the latter show the Lower Silurian limestones. Some of these faults are stupendous, bringing the Knox sandstone into contact with the Quinnimont Group, a vertical extent of not less than 8000 feet. While these faults have led to the removal of the coal beds almost wholly from the faulted area, they have made fair amends by bringing to the surface more than once the ore-bearing

groups known as the Lower Helderberg, Clinton and Knox or Calciferous.

The existence and excellence of the iron ores of Southwest Virginia have been known for many years; but the chief interest of the region now centers in the coal deposits, whose value and accessibility have been ascertained very recently. The coal occurs at three horizons:

The Coal Measures,
The Quinnimont Group,
The New River Group.

The area of the *Coal Measures* in Virginia is comparatively small, probably less than 600 square miles, the greater part of the field being in Kentucky and West Virginia. It occupies portions of Lee, Wise, Russell and Buchanan Counties, lying along the Kentucky border. The most readily accessible part is that in Lee and Wise Counties, and is drained by Powell River, a large stream entering Clinch River near Knoxville, Tennessee. Stone Mountain, a bold ridge of vertical conglomerate and the southeastern wall of the coal-field, is broken by two gaps, through which the Powell River and its North Fork flow. These can be reached by following the river from Knoxville, or by a shorter, though more difficult, route from Bristol, on the Norfolk and Western Railroad. The latter route has been chosen, and a narrow-gauge railway is in course of construction.

Measurements on the head waters of Powell River, behind the "Big Stone Gap," afforded me a vertical section of nearly 2500 feet of Coal Measures, containing twenty-one *coal beds*, varying in thickness from four inches to fifteen feet; but the productive part of the section is confined to the lower 920 feet, the beds higher up being very thin. This section doubtless represents all the Coal Measure groups of Pennsylvania, but detailed comparisons are impossible for the present, there being no limestones or other fixed horizons to be used for that purpose.

Four of the *coal beds* deserve notice. Two beds of *splint* are found high up in the productive portion of the section. They are separated by an interval of 70 feet, and are from 3 feet 6 inches to 4 feet thick. Their coal is a hard gray splint, very like that obtained on the Kanawha. Analyses by Mr. A. S. McCREATH show that this Powell River splint contains little more than 3 per cent. of ash and less than one-half of one per cent. of sulphur. The *Kelly Coal-bed*, 215 feet below the lower splint, is from 2 inches to 15 feet thick, but in a large part of the area maintains a thickness of from 5 to 7 feet. The middle bench, 2 feet 6 inches thick, is an admirable *gas coal*; the lower bench is a fair splint, while the upper bench is worthless. Mr. McCREATH found in the middle bench, .890 per cent. of ash, .771 per cent. of sulphur, while the volatile matter is 38.850. The *Imboden bed* is 50 feet

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below the *Kelly*, and varies in thickness from 6 feet 11 inches to 8 feet 5 inches. Its top bench is splint, about one foot thick, which gives excellent support to the roof. The rest of the bed yields an admirable coal, somewhat softer than the Pittsburgh, but harder than the Connellsville, so that it will bear shipping very well. A section of this bed yielded Mr. McCREATH: Volatile combustible matter, 35.920; Sulphur, 0.594; Ash, 1.515. This is an excellent *coking coal*, and its coke should contain not more than three or four per cent. of ash with a half per cent. of sulphur. Its excellence will be seen by comparison with Connellsville coke, which contains 9 to 13 per cent. of ash, or New River coke, with 6 to 7 per cent., or Oxmoor coke, with 5 to 6 per cent. Some of the lower beds in the section are workable, but in view of the larger beds, they are unimportant.

As this area lies beyond the faulted region, the dip is gentle. The forks of Powell River are long and flow in deep gorges, so that an enormous area can be worked without resort to artificial drainage. It is estimated that from 50,000 to 70,000 acres can be reached in this way at the head-quarters of Powell River, and that an area half as large is equally available on the North Fork of that stream.

This series is persistent in Russell and Buchanan Counties, where beds apparently answering to the *Lower Splint*, *Kelly*, and *Imboden*, have been discovered; but the character of the coal has not been tried.

The *Quinnimont Group* of Virginia and West Virginia is equivalent to the Seral or Pottsville Conglomerate of Pennsylvania. It is unimportant in Lee and Wise Counties, attains its maximum importance before New River is reached, and thence gradually decreases, until in Randolph County, of West Virginia, it again becomes unimportant. The series is 1000 feet thick on Powell River, where it has six coal beds, all very thin and without value except to supply domestic fuel. A section of about 600 feet of the lower part of the group was obtained on the Laurel Fork of Bluestone Creek, at the eastern end of Tazewell County. This shows 9 coal beds, varying in thickness from 6 inches to 11 feet. This area can be reached without much difficulty, from the Chesapeake and Ohio Railroad, or by a route following New River from the Norfolk and Western Railroad to the mouth of East River, and thence up the latter stream to its head, where, by crossing a narrow summit, the Laurel Fork is reached. A road is in course of construction along the latter route. Two of the *coal beds* merit especial attention. The *Nelson bed* shows from 5 to 9 feet of coal, the thickness being greatest on Laurel Fork, but less and less as one goes thence toward New River. The *Coal Branch bed*, 60 to 70 feet higher in the series, is from 5 to 8 feet thick, the latter on a branch of Laurel Fork. The quality of both these beds appears to

deteriorate eastward. Analyses of these coals from Laurel Fork, made by Mr. McCREATH, show the volatile matter to vary from 20 to 21 per cent.; the sulphur from 3 to 4-tenths of one per cent.; while the ash is little more than 2 per cent. For the most part, the dip of these beds is gentle, and they are available for a long distance. The coal is very soft and will not bear handling, but it can be mined very cheaply. Its coke is marvelously clean, and should be fully equal to that manufactured on New River. It should be as pure as that from the Powell River coals; but the low percentage of volatile matter will detract from its strength. At the same time, the volatile portion is greater than in the Broad Top and New River coals, both of which yield coke which bears well the burden of 60 feet stacks.

The *New River Series* belongs to the Vespertine or Pocono of Pennsylvania. The coal bearing part of this group is wanting in Scott and Lee Counties, but it develops rapidly north-eastward, where it has been studied by Lesley and Fontaine. The beds attain their greatest thickness in the south-eastern side of the area, where, alongside of the faults, small patches have escaped erosion. Some of the beds are from 5 to 8 feet thick; but, for the most part, the coal is inferior in quality and contains much ash. The volatile matter is low, and the coal is usually spoken of as anthracite or semi-anthracite; its economic value is insignificant.

The *iron ores* are brown hematite and "fossil ore" (Clinton), with here and there a little magnetite. The Lower Helderberg yields brown hematite, which fills pockets or cavities in the limestone. This ore abounds in Scott and Wise Counties, on Clinch River and its tributaries; but its quality varies annoyingly. At some localities it is very sandy, while at others it is clean enough for Bessemer treatment. Mr. McCREATH'S analyses show the variations to be: Metallic iron, 41. to 52.; Sulphur, .030 to .060; Phosphorus, .057 to .890; Insoluble matter, 7.840 to 22. The ore from some of the pockets has been smelted in open-hearth forges.

The *Clinton* ores have been brought up along five lines, most of which are unbroken from New River to beyond the Tennessee line. The importance of these ores was recognized by the Director of the third Geological Survey of Kentucky, and a corps carefully studied and reported on the series as shown along Stone Mountain for 60 miles from the Tennessee line. These ores are rather higher in metallic iron than those of the same series in Pennsylvania, and are very low in phosphorus, seldom showing more than 11 hundredths of one per cent.

The *Calciferous* ores, those of the Knox group, are exposed in a broad area. They occur in great pockets, and have been prospected extensively within the mountain area of Scott and Russell Counties,

within the last fifty years, to supply a forge in the former county. These ores are the same with the brown hematites of the Great Valley, on which all the furnaces between New River and the State line depend for supply. For the most part this ore is of excellent quality, and Mr. McCREATH'S analysis shows 58 per cent. of metallic iron, with only 75 thousandths of one per cent. of phosphorus, and less than 4 per cent. of insoluble matter. It is not improbable, however, that the ore may average higher in phosphorus than the sample analyzed.

Manganese occurs with these Lower Silurian ores, and sometimes it is of excellent quality. At one locality ore was obtained which has 81.45 per cent. of oxide of manganese, with but 27 thousandths of one per cent. of phosphorus.

The Tennessee marbles, belonging to the Trenton Group, must not be overlooked. These occur in the area lying behind Clinch Mountain, where the quantity is almost inconceivable. A number of samples from Estillville, in Scott County near the State line, were polished, and eight of them were regarded by dealers as belonging to the first grade.

The following paper was read by title:

"INDEX TO THE LITERATURE OF ELECTROLYSIS AND ITS APPLICATIONS, 1784–80;" by W. WALTER WEBB, assistant in the Scientific department of Trinity College, Hartford, Conn. This paper will appear in the Annals, forming another member of the series of Indexes to the Literature of Chemistry, therein contained.

May 1, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The report of the Council was read, recommending the election to Resident Membership of

Rev. EDWARD PAYSON THWING,

Rev. B. F. DA COSTA.

Their election was voted unanimously.

Mr. W. LECONTE STEVENS exhibited and described

AN IMPROVED FORM OF ORGAN-PIPE SONOMETER.*

Dr. B. N. MARTIN read an extended notice of the life and works of the late Prof. JOHN W. DRAPER.†

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* Published and illustrated in the American Journal of Science, 1882.
† Published in full in the Magazine of American History, 1882.

May 8, 1882

SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-three persons present.

Mr. G. F. KUNZ exhibited choice specimens of several varieties of feldspars, including "moonstone" from Ceylon, and from Chester County, Penn., "sunstone" from Chappaqua, N. Y., oligoclase from Norway, etc.

He also announced the death, on May 5, of a Corresponding Member of the society, Mr. WILLIAM S. VAUX of Philadelphia, long eminent as a mineralogist, and a leading patron of science in the city of his home. Mr. KUNZ made special reference to the extent and elegance of his celebrated collection.

The PRESIDENT spoke further of Mr. VAUX, and particularly of his active connection with the Academy of Sciences of Philadelphia, and with the American Association for the Advancement of Science.

Prof. H. L. FAIRCHILD then gave the address of the evening, largely illustrated with blackboard drawings and lantern views, on the subject of

METHODS OF ANIMAL LOCOMOTION.

(Abstract.)

Self-motion is the most prominent characteristic of life. This remarkable power of overcoming the forces of Inertia and Gravitation is not confined to animals. Many plants have, besides the capability of upward growth and extension, more or less motion of some organs. In the lowest forms of life, plants and animals can not be distinguished by their locomotive powers. Many microscopic plants move about in water as lively as animals, and propelled by similar organs. Nor can the movements be distinguished as voluntary in animals and involuntary in plants. Consciousness and will are not more evident in the lowest animals than they are in the Venus Fly-trap and the Sensitive Plant.

It is doubtless true that all animals can move from place to place at some period of their life. For example the coral polyp, oyster and barnacle possess locomotive powers only in the embryo state, becoming fixed in the adult; while in some other animals, as the jelly-fish these conditions are reversed.

The means of locomotion are exceedingly various. The lowest method is exhibited by the amoeba, in which progression is secured by

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